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Happy 20th birthday Euro: An integrated analysis of the stability status in the Eurozone's equity markets

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Abstract. We celebrate the 20th anniversary of the introduction of the Euro by reviewing one of the key elements: the integration of the Eurozone financial markets. Introducing a multivariate volatility test based on the asymmetrical BEKK (ABEKK) multivariate GARCH model of volatility to analyse the stable market pre-condition hypothesis of the integrated Eurozone equity markets across the euro's timeline. Extending our analysis to the impact of the rise of the populist political movement on the Eurozone financial markets during the last few years. The first and most important contribution is the introduction of a multivariate volatility test based on the ABEKK to analyse the stability of the integration in the Eurozone equity markets. However, another key contribution is the analysis of a period where the whole concept of European integration is coming into question by the rise of the populist political movement. This research could be of importance to the ECB in stabilising the Eurozone financial markets as well as market participants in portfolio optimization within the Eurozone. Our results point to a difference in financial market integration depending on the definition. The empirical evidence found that market participants tend to react differently according to the affinity of the market participants to the event/news. In essence, market participants are driven by the "time and space" effect. This would point to evidence that the Eurozone equity markets was never truly integrated in the econometrics sense as defined later on. However, our literature review did identify evidence that the Eurozone equity markets was integrated in accordance with the definition of Baele *et al.*, (2004). Hence it really does depend on the definition used. Generally, our policy recommendations are for a committee to be setup to unify the communication and actions of the European Union during crises. A better way of communicating the work and concept of the European Union to the population. Finally, a slower paced policy of integration to overcome the sense of loss national identity which recently many are plying on.
Keywords. Euro, European integration, Volatility test, Asymmetric BEKK, Multivariate GARCH, Volatility spillover, News contagion, Equity markets.
JEL. C12, C58, E44, F36, G15.

1. Introduction

The introduction of the Euro was probably one of the most significant financial events of the last century, not only because of the introduction of a new currency across the Eurozone but also it contains an influencing concept. At its heart lays a strong ideology in order

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to prevent conflicts between the countries of Europe, like the first and second world wars, there is a need to integrate the economies and financial markets under one currency and monetary policy. Conversely, on 1st January 1999 the euro was first introduced into 11 countries, hence integrating 11 diverse economies and financial markets under one common monetary union. However, the recent further integration is one of the reasons for the fresh increase in the popularity of the populist/nationalist political movements, especially in the aftermath of the crises and economic downturns, due to the loss of a "national identity" and/or "economic constraints". We introduce a multivariate volatility test using an asymmetrical BEKK MGARCH model first proposed by Engle & Kroner (1995); analysing the stability of the integrated Eurozone financial markets through six different observed periods in the timeline of the euro including the recent rise of populist political movements.

Although, many papers have been written on the impact of the euro on the integration of the financial markets across the Eurozone during the introductory and crises periods. Moreover, there is an extensive library of research on the impact of the euro on the volatility spillover effect and contagious impact of news within the Eurozone. Yet a key issue remains understudied; the stability of the Eurozone markets which was highlighted by the recent financial and sovereign debt crises and extended by the recent rise in the populist political movement, such as the Brexit process or rise of populist political parties, which puts into question the whole concept of European integration.

As argued by Fakhry (2019), since the volatility test indicates that if a market is inefficient then it is deemed to be too volatile to be efficient. Simply put, this means that for a market to be efficient the pre-condition is a measurable stability status. Thus, meaning that essentially the volatility test is a test of the stability pre-condition. In a number of collaborations such as Fakhry & Richter (2016, 2018) using the volatility test, found diverse evidence of market stability in the Eurozone financial markets during the recent global financial and Eurozone sovereign debt crises. While Fakhry (2019) analysing the impact of Brexit on the UK's financial markets found that populism politics could destabilize a market.

Recent studies such as Dotz & Fisher (2011), Metui (2011), Tamakoshi (2011) and Mohl & Sondermann (2013) point to a changing behaviour in the integrated financial market depending on the general market environment. This was confirmed by Fakhry & Richter (2018) who find that the stability of the financial markets may vary among markets and depend on the general environment. Conversely, as illustrated by Pericoli & Sbracia (2003) the evidence on contagion and spillover effects are strong. Furthermore, as noted by Pericoli & Sbracia (2003), this evidence is not limited to countries within a region but there is also evidence of cross regions volatility transmissions. Louzis (2013) also notes the strong evidence of cross markets spillover effects during the crises highlighting the volatility transmission between the stock and sovereign debt markets during the Eurozone sovereign debt crisis.

Although as Christiansen (2007) demonstrated that it is possible to model volatility spillover effects using an univariate GARCH model. Moreover, the VAR as illustrated by Louzis (2013) could be used to identify spillover effects using Diebold & Yilmaz (2012) methodology. Furthermore, as illustrated by Billio & Pelizzon (2003) and Baele (2005), spillover effects can be detected using a multivariate Markov switching model. However, Multivariate GARCH models are more flexible and thus often used in the study of spillover and contagious effects such as (Missio & Watzka, 2011, Favero & Missale, 2011; Groba *et al.,* 2013; MacDonald *et al.,* 2018; Trabelsi & Hmida, 2018).

To this extent, we use an asymmetrical BEKK-MGARCH (aka ABEKK) model to analyse the impact of volatility spillover effect and contagious impact of news on the Eurozone financial markets since the introduction of the euro. We also introduce a multivariate variant of the volatility test to analyse the stability of the environment in the Eurozone financial market. We restrict our analysis by using the EuroStoxx 50 index as the benchmark market, thus meaning we analyse the transmission of volatility and news between each observed equity market and the EuroStoxx 50 index. Using the equity markets from the 10 original members of the Eurozone[2]plus Greece [3] observed from 31st December 1997 to 31st December 2018. Furthermore, we use timeline analysis to research the impact of six different periods associated with the pre-euro, introduction of the euro, mid-2000s global asset price bubble, recent crises (i.e. global financial and Eurozone sovereign debt crises) and rise of populist movement in the last few years.

Our key contribution to the literature on financial econometric is the extension of the volatility test of Fakhry & Richter (2016a) to a multivariate volatility test using an ABEKK model. This would allow us to test the stable market precondition hypothesis, as proposed by Fakhry (2019), in the context of a multivariate environment. Therefore, analysing the environment underpinning the transmission of volatility and news from one market to the other within the Eurozone integrated financial market. Although, the ABEKK have been used to analyse the transmission of volatility such as (Wang & Wang, 2005; Li, 2007; Efimova & Serletis, 2014; Emenike, 2014); yet mainly due to the complex nature of such a model and estimation issues, the ABEKK model has been sparingly used in the context of the Eurozone financial markets integration.

Since as hinted by Bekaert *et al.* (2002) and Baele (2005), a fully integrated market displays interdependency and correlated returns amongst its segments; thus it is one where news contagion and volatility

[2] As with other researches in the Eurozone, we don't analyse the Luxemburg financial market.

[3] Although Greece did not join until 1st January 2001, yet we feel that Greece is an important market mainly due to the sovereign debt crisis.

spillover from one segment effects all segments. In general, our results suggest that the market participants within the Eurozone subscribe to the "time and space" effect meaning they tend to react differently to events depending on the time horizon and market. In essence, market participants react differently according to their affinity to the event. Thus suggesting the Eurozone equity markets was never truly fully integrated.

Given our findings and the latest views on further integration, we recommend a slower pace of integration for the foreseeable future to overcome the loss of national identity which gives rise to extreme views. We also advise the European parliament to communicate more with the population in order to raise awareness of the work and concept of the European Union. A key issue raised by the recent crises within the Eurozone and the European Union is miscommunication, we recommend the setup of a committee to oversee the communication and actions during any event.

We follow the convention by firstly reviewing the literature on the Eurozone financial markets integration. Secondly, we review the methodology of the model specifications of the ABEKK MGARCH and our multivariate volatility test. Thirdly, we review our observed data. The fourth section provides our empirical evidence on the stability of the Eurozone integrated equity markets, analysing the volatility spillover effects and impact of contagious news over six periods during the timeline of the euro. Concluding with the conclusions and recommendations.

2. A literature review of the Eurozone's integrated financial markets

In order to understand the impact of the spillover and contagion effects, we need to research the impact of integration on the Eurozone equity market. Baele *et al.*, (2004) defines an integrated financial market as a market for financial instruments and services where all market participants are governed by three principle characteristics:

1. a single set of rules regarding the purchase or selling of instrument or services.
2. equal access to instruments and services.
3. equal treatment for all market participants engage in a market.

As stated by Baele *et al.*, (2004), economic theory dictate that the integration and development of financial markets are key to economic growth in the Eurozone by removing frictions and barriers and allocating capital more efficiently. However, a key issue is taken a step too far financial integration could be detrimental to market competition as highlighted by Baele *et al.*, (2004). Further, a key argument made by Baele *et al.*, (2004) is that financial integration may affect the structure and hence have implication for the stability of the financial system.

According to Cohen (2003) many economists and academics predicted the Euro will challenge the dollar for global supremacy, for many at the time the question was not if but when. Relatively few, such as Feldstein

(1997), questioned the enthusiasm towards the new currency. As quoted by Cohen (2003, p.576), many predicted "*a rosy future*" for the new currency. However, according to Cohen (2003) there were four major obstacles standing in front of the euro challenging the dollar as the global currency at the time: firstly, the persistent inertia behaviour of monetary systems. Secondly, the cost of doing business in euros. Thirdly, the "anti-growth" bias built into EMU and finally the ambiguous governance structure of the EMU. Although as Cohen (2003) states these obstacles could be overcome. Conversely, Papaioannou *et al.*, (2006) found that the influence of the Euro as the reference international reserve currency of the central banking environment was growing and accordingly "*Punching above its weight*".

Ehrmann & Fratzscher (2002) found in the immediate aftermath of the introduction of the euro macroeconomic news from the US had more impact on the Eurozone financial markets than vice-versa. However, the importance of macroeconomic news, especially the M3 monetary levels and CPI, from the Eurozone grew in the later stages of the Euro's introduction period.

Reviewing the impact of the euro on the financial markets after one year, Danthine *et al.*, (2000) found evidence illustrating the euro did have an immediate impact on the Eurozone financial markets. However, the impact was not mainly due to the elimination of currency risk but a result of indirect feedback mechanisms. These feedback mechanisms include the cross-country transaction costs, liquidity of the Eurozone's financial markets, diversification opportunities available for Eurozone investors and institutional changes effecting the banking sector.

As Trichet (2001) states the euro had a huge impact on the Eurozone's financial markets. Across the board, the Eurozone financial markets grew in the aftermath of the introduction of the euro. A key factor in the equity market was the growth in mergers and acquisitions totalling over $1 trillion during the initial two years of the euro. An important factor in this is the trend towards the merger or cooperation between stock exchanges i.e. the Euronext stock exchange which was created by the merger of the exchanges in Paris, Brussels and Amsterdam. In the aftermath of the introduction of the euro, the total market capitalisation of the Eurozone's equity market stood at €5.5 trillion in 1999 as oppose to €3.6 trillion in 1998. According to Trichet (2001). The contributory factors to this growth are not only the rise in price but also the IPO of private companies. However, as Trichet (2001) states there were still some barriers to further integration of the Eurozone's financial markets; hinting at the Lisbon meeting of the European Council in March 2000 as a landmark in the integration of the European financial markets.

Conversely, in a study of the impact of the euro on the European financial markets after four years, Galati & Tsatsaronis (2003) noted the impact is uneven across the spectrum of the financial market. In many respects the euro have had a positive impact i.e. the redirection of prices in the equity market to reflect industry risk factors as oppose to country risk factors and lower cross border transaction barriers. These positive impacts have enhanced the ability for investors to build pan-European strategies and portfolios. However, Galati & Tsatsaronis (2003) found there were still issues with implications on financial markets integration; like the focus on narrowly defined interests meaning the potential of European Monetary Union to integrate financial markets may not be fully realised. Another issue highlighted is diverged legal and institutional infrastructures and market practices which may impede on further development of the Eurozone financial markets.

According to Fratzscher (2001), European equity markets have become increasingly integrated since 1996. This integration is largely driven by EMU and is at the heart of the Eurozone's equity market overtaking the US equity market within Europe. Furthermore, Baele *et al.*, (2004) found evidence hinting at an increasingly integrated equity market pointing at three key elements of the Eurozone financial markets:

- The advantages of sector diversification have surpassed those of country diversification.
- Equity returns are increasingly determined by common news factors.
- The decrease in home bias within financial institutions' portfolios.

Moreover, the results from Hardouvelis *et al.*, (2006) points at diminishing forwards interest differentials against the German benchmark and inflation differentials have been key to the integration of the equity markets during the 1990s. Significantly, the exception was the UK's equity market. Conversely, Lane & Walti (2006) found evidence pointing at strong bilateral financial linkages within the Eurozone. However, the results seem to suggest that there are other factors than EMU also driving the financial integration.

Nevertheless, Cappiello *et al.*, (2006) found the integration of Eurozone equity markets was not as strong as the bond markets and was determined by the size of the economy with integration being greater in the large economies. And as Bekaert *et al.*, (2013) found that it is EU membership rather than euro adoption that have increased financial integration. Thus, meaning European equity markets segmentation decreased with EU membership.

An important issue in this paper is the study of the spillover and contagion effects on the Eurozone financial market. Much of the empirical evidence in the past few years have concentrated on the spillover and contagion effect on the Eurozone sovereign debt market during the crises of the late 2000s to mid-2010s. Good examples of recent research in spillover and contagion effects in the Eurozone sovereign debt markets during the crises are Missio & Watzka (2011), Favero & Missale (2011) and Groba *et al.*, (2013). Since this paper is partly researching and analysing the volatility spillover and news contagion of the Eurozone equity market, therefore we will provide empirical evidence on the equity market.

In essence as stated by Groba *et al.*, (2013), a vital factor in the behaviour of volatility in any financial market is the transmission of volatility from one asset or market to another; often referred to as the volatility spillover effect. The introduction of the VEC by Bollerslev *et al.*, (1988) was aimed at the co-movement in the time varying volatility between two or more assets or markets. The BEKK introduced by Engle & Kroner (1995) had the advantage of the conditional covariance matrices being positive definite by construction as stated by Silvennoinen & Terasvirta (2008). However as hinted by Silvennoinen & Terasvirta (2008) a major problem is due to the number of parameters required in the BEKK; the sheer computing power was prohibiting on most computers. This meant convergence using the BEKK model was and still is difficult.

Using a multivariate regime switching model and world and German indices as benchmarks markets, Billio & Pelizzon (2003) found volatility spillover increased from both benchmarks to most European equity markets since the introduction of the Euro. Furthermore, introducing a regime-dependent shock spillover intensities variant of the Markov switching model, Baele (2005) hints at an increase in intensity in the spillover effects for the European Union throughout the 1980s and 1990s. The key contributory factors are increased trade integration, equity market development and low inflation. Moreover, Baele (2005) found some evidence of contagion during highly volatile periods.

Missio & Watzka (2011) use a DCC multivariate GARCH model to analyse the contagion effect of sovereign debt credit ratings during the Eurozone sovereign debt crisis in seven Eurozone yield spreads. They use the announcements on the Greek credit ratings to analyse the financial contagion between the Greek market and the other observed yield spreads. The results hint at a strong financial contagion from the credit ratings announcement, especially around the first bailout of the Greek economy during the summer of 2010. Furthermore, the results imply contagion only effect economically or politically unstable countries. Similarly, Groba *et al.*, (2013) using the BEKK model on CDS from EU members found a varied transmission of risk from the GIPSI[4] countries to other EU members during the crises period. Like Missio & Watzka (2011), the results hint at a fragmentation of the EU between financial distressed members and other members.

Louzis (2013) constructed spillover indices based on Diebold & Yilmaz (2012) framework which uses a generalised decomposition of the forecast-error variance of a VAR model. In general, they found a high level of return and volatility spillover effect over the observed markets. Moreover, the equity market was the largest transmitter of return and volatility spillover, even during the recent sovereign debt crisis.

MacDonald *et al.*, (2018) using a BEKK model found that the direction and intensity of the spillover effect is time dependent. Although the GIPSI

[4] GIPSI are Greece, Italy, Portugal, Spain and Ireland

nations are occasionally the largest contributors of the spillover effects, however the core Eurozone countries also transmit volatility to the GIPSI. Conversely, the results point to the existence of cluster of countries, hence the spillover effect comes from within the group ((i.e. Core or Periphery). Moreover, Trabelsi & Hmida (2018) using a DCC-MGARCH model and a limited number of Eurozone equity markets showed during the recent financial crisis there was the existence of contagion between all observed markets. However, the results from the sovereign debt crisis points to only Greece and Portugal being impacted by contagion.

3. Methodology

The importance of a stable environment underpinning the Eurozone financial markets was underlined during the crises period as illustrated by any number of researches during the last few years such as Groba *et al.*, (2013), MacDonald *et al.*, (2018) and Trabelsi & Hmida (2018). The impact of volatility spillover and contagion of news from one market to the other market within the Eurozone is a hot debate that is just as relevant today as it was during the crises and euro introductory periods. Therefore, we extend the volatility test proposed by Fakhry & Richter (2016a) to a multivariate volatility test using an asymmetrical BEKK-MGARCH model proposed by Engle & Kroner (1995). We use the 5% critical value F-statistics to test the stable market pre-condition hypothesis. As with Fakhry & Richter (2016, 2018), we follow the key pre-requisite step advocated by Shiller (1979, 1981).

As illustrated by Shiller (1981), the key factor underlying any volatility test is the variance calculation. We model the datasets in our test as a time varying lagged variance of the price using equation 1. We used the 5-lagged system as advocated by Fakhry & Richter (2016a)

$$\lim_{t\to T} var(Price_{i,t}) = \frac{\sum_{q=1}^{Q}(Price_{\,i,q} - \mu_i)^2}{Q} \tag{1}$$

However, since we are only concerned with the stability of the transmissions of volatility between the markets and thus the integration of the Eurozone markets; we don't follow step 2 of Shiller (1981) estimating the residuals using an autoregression model.

3.1. Model specifications for theABEKK bivariate GARCH

As illustrated by Christiansen (2007) and Ball (2009) among others, a key factor in the behaviour of volatility is the influence of volatility from related external sources. And while the volatility spillover effect could be estimated using a univariate GARCH model as demonstrated by Christiansen (2007) thru the use of a three-step technique. Yet we think that a more elegant method to our observed data would be to use a multivariate GARCH model. There are a number of MGARCH models as surveyed by Bauwens *et al.*, (2006) and Silvennoinen & Terasvirta (2008); chief among these models are the BEKK-MGARCH (Engle & Kroner, 1995) and DCC-MGARCH (Engle, 2002). We use theABEKK model to model the conditional covariance of our observed equity market indices.

One of the key contributions of our research is the use of a bi-variate ABEKK model. As hinted previously, we differ from previous research into the integration of the Eurozone markets in that we use the EuroStoxx 50 index as the benchmark equity market. Thus, analysing the spillover and contagion effects between the benchmark and observed11 Eurozone members in all six stages of the Euro's timeline.

The reasoning behind our choice of the ABEKK is the restrictions of the other MGARCH models in order to guarantee the positivity of the conditional covariance, thus rendering our results unusable. In order to overcome these restrictions, we chose to use the unrestricted BEKK model. However, the big issue with using any unrestricted BEKK model is the large number of parameters and thus computing power required. In a normal BEKK, each coefficient matrices have a $N \times N$ number of parametersplus a C matrix has $\frac{N(N+1)}{2}$ parameters and lastly there are the N parameters for the mean equation. However, we are using the more complicated ABEKK which adds an asymmetrical matrix, D, with $N \times N$ parameters. With this number of parameters, it is highly likely that one reason why the unrestricted ABEKK have been used sparingly in econometric research is the sheer computing power it requires. Another possible issue with the unrestricted ABEKK is the difficulty to get convergence.

Our single lag ABEKK (1, 1) would be modelled using equations 2 and 3.

Mean Equation

$$\mu = \mu_{Euro} + \mu_i \quad (2)$$

Covariance Equation

$$H_t = CC' + Au_{t-1}u'_{t-1}A' + BH_{t-1}B' + Dv_{t-1}v'_{t-1}D' \quad (3)$$

where

$$v_{t-1} = u_{t-1} \circ I_{u<0} u_{t-1},\ u_{t-1} = [u_{euro,t-1} u_{i,t-1}]' \text{ and } v_{t-1} = [v_{euro,t-1} v_{i,t-1}]'$$

H_t *and* $H_{t-1}$is the conditional covariance at time t or t-1

$u_{t-1}$is the conditional residuals at time t-1

C is the constant term

A is the coefficient matrix of the conditional residuals or ARCH

B is the coefficient matrix of the conditional covariance or GARCH

D is the coefficient matrix of the asymmetrical effect

Since, we are using a bi-variate system to test the transmission of news and volatility between the euro index and the other Eurozone indices. The generalised matrix system is as in equation 4.

$$C = \begin{vmatrix} \omega_{11} & \omega_{12} \\ 0 & \omega_{22} \end{vmatrix}, A = \begin{vmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{vmatrix}, B = \begin{vmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{vmatrix}, D = \begin{vmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{vmatrix} \quad (4)$$

Therefore, when our model is split into its component parts, we can write the components using equations 5-7.

Variance of the Euro equity market benchmark

$$\begin{aligned} h_{1,t} = {} & C(1,1)^2 + A(1,1)^2 u_{1,t-1}^2 + 2A(1,1)A(2,1)u_{1,t-1}u_{2,t-1} + A(2,1)^2 u_{2,t-1}^2 \\ & + B(1,1)^2 h_{1,t-1} + 2B(1,1)B(2,1)\sigma_{(1,2),t-1} + B(2,1)^2 h_{2,t-1} \\ & + D(1,2)^2 v_{1,t-1}^2 + 2D(1,1)D(2,1)v_{1,t-1}v_{2,t-1} + D(2,1)^2 v_{2,t-1}^2 \end{aligned} \quad (5)$$

Variance of the ith Eurozone market

$$\begin{aligned} h_{2,t} = {} & C(2,1)^2 + C(2,2)^2 + A(1,2)^2 u_{1,t-1}^2 + 2A(1,2)A(2,2)u_{1,t-1}u_{2,t-1} \\ & + A(2,2)^2 u_{2,t-1}^2 \\ & + B(1,2)^2 h_{1,t-1} + 2B(1,2)B(2,2)\sigma_{(1,2),t-1} + B(2,2)^2 h_{t-1} \\ & + D(1,2)^2 v_{1,t-1}^2 + 2D(1,2)D(2,2)v_{1,t-1}v_{2,t-1} + D(2,2)^2 v_{2,t-1}^2 \end{aligned} \quad (6)$$

Covariance of the Euro and ith Eurozone equity markets

$$\begin{aligned} \sigma_{(1,2),t} = {} & C(1,1)C(2,1) \\ & + A(1,1)A(1,2)u_{1,t-1}^2 + \\ & \big(A(1,2)A(2,1) + A(1,1)A(2,2)\big)u_{1,t-1}u_{2,t-1} \\ & + A(2,1)A(2,2)u_{2,t-1}^2 \\ & + B(1,1)B(1,2)h_{1,t-1} + \\ & \big(B(1,2)B(2,1) + B(1,1)B(2,2)\big)\sigma_{(1,2),t-1} \\ & + B(2,1)B(2,2)h_{1,t-1} \\ & + D(1,1)D(1,2)v_{1,t-1}^2 + \\ & \big(D(1,2)D(2,1) + D(1,1)D(2,2)\big)v_{1,t-1}v_{2,t-1} \\ & + D(2,1)D(2,2)v_{2,t-1}^2 \end{aligned} \quad (7)$$

Under our ABEKK specification, the conditional covariance is estimated using equation 3. It is worth noting that the general equation dictates that the conditional covariance at time t depends on the conditional covariance and the product of the residuals multiplied by the inverse residuals at time t-1.However, the key point is the three $N(N+1)$ coefficient matrices and the raw coefficient matrices. These represent the constant, ARCH and GARCH coefficients in the ABEKK.

Of importance is the matrices A, B and D as highlighted in equation 4.Since we are only interested in the transmission between two markets, the key to the interpretation is the off-diagonal coefficients in all three matrices. As intended by Engle & Kroner (1995), the key to interpreting the ABEKK lays in the three matrices coefficients: A,B and D. Furthermore, as hinted by Engle & Kroner (1995), these coefficients translate into the market shock and volatility transmissions from one market to the next. Put simply, as

Kim *et al.* (2015) and MacDonald *et al.*, (2018) states the A matrix coefficient reflects the *"news contagion effect"* and the B matrix coefficient represents the *"volatility spillover effect"*. Thus, meaning that a statistically significant value for A(m, n) can be interpreted as the impact of news from market m onmarket n. In the same way, a statistically significant value in the B(m, n) coefficient may be interpreted as the volatility spillover between markets m and n. As intended by Engle & Kroner (1995), the standard ABEKK implies that only the magnitude of the past returns is important in determining the current conditional covariance. Hence, we only need to use the magnitude of the A and B matrices coefficients to interpret the news and volatility spillover effects. Interestingly, the asymmetrical effect, matric D, could be interpreted as the impact of news from market m on the volatility of market n. In other words, a leverage effect is the transmission of bad news from market m to the volatility of market n. Since the leverage effect captures the transmission of bad news, it is logical to say that a positive asymmetrical effect could be interpreted as the transmission of good news from market m to the volatility of market n.

3.2. Specification of the multivariate volatility test

The coefficients of the ABEKK model of volatility are also key to our multivariate volatility test. It is essential to note that like Fakhry (2019), we use our volatility test to analyse whether the market is stable or volatile. As mentioned earlier in this section, we derive our stability test by using the f-statistics; for our observed samples, the f-statistics at the 5% level is 1.96. We calculate our stability test statistics using equations 8 and 9 as the stability status of the transmission. Since as stated earlier, we are only interested in the transmission of volatility from the benchmark euro market to market n and vice-versa, thus we only used the off-diagonal matrices.

$$Stability\ Test_{Euro\to n} = \frac{(A_{Euro,n} + B_{Euro,n} + D_{Euro,n}) - 1}{sdev(var(Euro)) + sdev(var(n))} \leq Fstatistics \tag{8}$$

$$Stability\ Test_{Euro\leftarrow n} = \frac{(A_{n,Euro} + B_{n,Euro} + D_{n,Euro}) - 1}{sdev(var(Euro)) + sdev(var(n))} \leq Fstatistic \tag{9}$$

Like the univariate volatility test of Fakhry & Richter (2016a), our multivariate volatility test consists of three coefficients: A, B, and D matrices representing the news contagion, volatility spillover and asymmetrical effects. However, since we are analysing a multivariate model of volatility, we use a two-factor denominator representing the standard deviations of the euro benchmark and Eurozone markets.

4. Data description

Essentially, this paper analyses the stability of the integrated equity markets from the 11 original Eurozone members to establish the impact of key periods in the life of the euro on the Eurozone financial markets against a Eurozone benchmark market. Hence, we use daily prices from the 11 equity markets listed plus the EuroStoxx 50 as the benchmark equity market obtained from investing.com. As with the norm, we chose to use a five-day week filling the missing data with the last known prices. With the exception of the Portuguese PSI 20 index, all the 11 remaining markets were observed between 31st December 1997 and 31st December 2018 meaning a total of 5,479 observations. However, the Portuguese PSI 20 index was observed from 4th January 1999 making a total of 5,216 observations.

Table 1.*Major Eurozone equity markets Indices*

Market	*Eurozone*	*Austria*	*Belgium*	*Finland*	*France*	*Germany*	*Greece*	*Ireland*	*Italy*	*Holland*	*Portugal*	*Spain*
Index	EuroStoxx 50	ATX	BEL 20	OMX H 25	CAC 50	DAX	ATHEX LC	ISEQ OA	MIB	AEX	PSI 20	IBEX 35

It must be noted that like all indices, the observed equity markets are based on weighted ratios of their component's prices. In common with many researches using the volatility test, such as Fakhry & Richter (2018), we used a modifier of 25 on the prices to overcome an issue with the variance calculations.

5. Empirical evidence

As hinted earlier, the key variables to our multivariate test of the stability in the Eurozone equity markets lay with the coefficients of the co-variance model and two standard deviation statistics. Essentially, this means the model of volatility is the key, we use a bi-variate ABEKK-MGARCH model. Thus, meaning we analyse the news contagious effect, volatility spillover effect and asymmetrical effect by interpreting the A, B and D matrices respectively. It is worth noting as stated earlier since we are only interested in the transmission effect from one market to the other market, we only report the off-diagonal matrices.

In estimating the models, we used the BFGS estimation method for all estimations. However, with the error distribution, we opted to use a mixture of normal and t-student distribution models to get the best estimation as illustrated by tables2 to 7. For all other options, we used the default settings. Crucially, the system environment may influence the estimation: our system is running Estima WinRATS Pro (64-bit) 9.20e on a Windows 10 Pro computer with a 10 cores CPU and 32 Gigabytes RAM6F6F[5].

5.1. Pre-Euro

During the period immediately before the introduction of the euro, the markets were split between enthusiasm and nervousness about the introduction of the euro. As hinted by Cohen (2003), relatively few questioned the enthusiasm; indeed, many predicted a rosy future.

[5] It is possible to have slightly different estimation results in different environments. However, the volatility tests should not be affected.

However, the markets were still slightly apprehensive about the introduction of the euro as highlighted by Bates (1999) and as stated by McCauley & White (1997) there were still many uncertainties surrounding EMU. And as Feldstein (1997) hints the fear was that EMU would lead to disagreements among the member states as for the right policies for a given circumstance. The other key issue during this period was the uncertainty bought about by the Russian default and LTCM Crises during the latter half of 1998 see (Dungey *et al.*, 2007; Lowenstein, 2000).

As explained in the methodology, the A matrices pick up the transmission of news. Hence a statistically significant $A_{Euro,i}$ matrix would be interpreted as the impact of news from the EuroStoxx on the Eurozone equity markets and vice-versa. As illustrated by Table 2, with the exception of the ATX and AEX, during the immediate pre-euro period news from the EuroStoxx had a significant impact on all the Eurozone markets giving a ratio of 8:2. However, news from the Eurozone markets did not have a significant impact on the EuroStoxx with the exception of the ATX, CAC and AEX intimating a ratio of 3:7. The B matrices indicate the volatility spillover effect, hence a statistically significant $B_{Euro,i}$ would be interpreted as the transmission of volatility from the EuroStoxx to the Eurozone markets. Table 2 seem to be hinting at six Eurozone markets being affected by the transmission of volatility from the EuroStoxx: CAC, DAX, ATHEX, ISEQ, MIB and IBEX hinting at a ratio of 6:4. Conversely, the EuroStoxx was affected by volatility from four Eurozone markets: AIX, OMXH, ISEQ and AEX suggesting a ratio of 4:6. As defined in the methodology, the D matrices is the asymmetrical effect; thus, in short indicates whether the transmitted news is good or bad. The results from the immediate pre-euro period seem to be hinting at a 7:3 transmission of bad news from the EuroStoxx to the Eurozone markets (ATX, BEL, CAC, ATHEX, ISEQ, MIB and IBEX). Furthermore, there is a 2:8 transmission of bad news from the Eurozone markets to the EuroStoxx with only the OMXH and CAC. The stability status of the transmission between the EuroStoxx and Eurozone markets seem to be hinting at a ratio of 6:4 with four markets being volatile: ATX, MIB, AEX and IBEX. Whereas the stability status of the transmission from the Eurozone markets to EuroStoxx is hinting at a ratio of 7:3 with the ATX, OMXH and AEX being volatile.

Table 2. *Stability Test for Pre-Euro Period (07/01/1998 - 31/12/1998)*

Market i	*ATX*	*BEL 20*	*OMX H 25*	*CAC 40*	*DAX*	*ATHEX LC*	*ISEQ Overall*	*MIB*	*AEX*	*IBEX 35*
Distribution	t-Student	Normal	Normal	Normal	Normal	Normal	Normal	Normal	t-Student	Normal
Mean Statistics										
μ_{Euro}	8.2772E-02	7.1454E-02	7.5285E-02	8.4374E-02	8.6885E-02	8.2504E-02	9.1931E-02	5.9678E-02	8.7844E-02	7.9791E-02
	(7.551E-03)	(1.085E-02)	(6.321E-03)	(2.944E-05)	(8.532E-03)	(6.920E-03)	(8.534E-03)	(5.248E-03)	(7.382E-03)	(6.495E-03)
μ_i	9.0271E-03	3.8159E-02	1.7895E-02	1.4127E-01	2.5395E-01	4.2959E+00	1.5790E-01	2.7400E+00	2.1924E-03	1.1026E+00
	(1.235E-03)	(7.121E-03)	(1.365E-03)	(6.961E-03)	(3.660E-02)	(5.211E-01)	(1.711E-02)	(2.487E-01)	(1.656E-04)	(7.339E-02)
Off Diagonal Co-Variance Statistics										
$A_{Euro,\,i}$	7.8386E-03	1.1957E-01	1.0417E-01	3.5509E-01	1.9995E+00	9.8435E+00	3.6564E-01	7.0437E+00	-9.0920E-05	3.6220E+00
	(6.691E-03)	(3.438E-02)	(1.544E-02)	(1.062E-01)	(2.845E-01)	(2.447E+00)	(7.837E-02)	(1.307E+00)	(4.590E-03)	(5.703E-01)
$A_{i,\,Euro}$	4.4204E-01	5.7976E-02	-5.3502E-02	1.2466E-01	-2.1521E-03	2.9895E-04	-2.8240E-02	-1.5726E-04	8.8016E+00	1.1438E-02
	(3.532E-01)	(7.275E-02)	(1.074E-01)	(5.568E-02)	(3.091E-02)	(4.692E-04)	(2.454E-02)	(1.339E-03)	(4.672E+00)	(5.165E-03)
$B_{Euro,\,i}$	7.2789E-03	-1.5334E-02	6.4176E-02	1.0647E-01	-2.4874E+00	-2.1172E+01	-2.1927E-01	2.4303E+00	-3.7133E-03	-3.2495E+00
	(8.114E-03)	(5.060E-02)	(1.415E-02)	(1.880E-01)	(3.171E-01)	(4.358E+00)	(9.152E-02)	(1.975E+00)	(3.403E-03)	(1.039E+00)
$B_{i,\,Euro}$	-1.1902E+00	9.1726E-02	-4.1121E-01	-8.3653E-02	-3.3513E-02	-2.5386E-03	1.2321E-01	-1.8348E-04	-1.0063E+01	-4.1190E-02
	(3.986E-01)	(9.398E-02)	(1.493E-01)	(1.280E-01)	(4.135E-02)	(9.750E-04)	(3.076E-02)	(2.070E-03)	(2.933E+00)	(7.338E-03)
$D_{Euro,\,i}$	-1.0000E-08	-4.4191E-02	3.2120E-01	-3.8847E-01	8.6483E-02	-2.1540E-05	-5.4125E-01	-5.2347E+01	2.8721E-02	-1.5695E+01
	(1.385E-01)	(2.864E-01)	(1.040E-01)	(6.874E-01)	(3.474E+00)	(2.722E+01)	(6.648E-01)	(2.362E+01)	(1.687E-02)	(5.170E+00)
$D_{i,\,Euro}$	7.8000E-07	1.6633E+00	-1.7586E-01	-4.7382E-01	1.0721E-02	3.0000E-08	4.9852E-01	1.5029E-02	5.7256E+01	1.1236E-01
	(1.316E+01)	(9.374E-01)	(3.860E+00)	(1.945E-01)	(4.285E-01)	(6.368E-03)	(2.080E-01)	(1.192E-02)	(4.408E+01)	(2.875E-02)
Model Statistics										
Log-Likelihood	783.8487	387.0287	592.7830	318.7714	53.5277	-840.8711	2,079.6663	-567.2480	1,341.8880	-336.1376
Final Criterion	5.60E-06	6.80E-06	4.10E-06	0.00E+00	9.00E-06	8.90E-06	2.70E-06	9.50E-06	4.80E-06	6.70E-06
Co-integration Volatility Test										
σ^2_{Euro}	0.327011									
σ^2_i	0.045969	0.248090	0.086727	0.448785	1.003011	18.007491	0.709850	8.700593	0.009436	3.918915
Stability Test ($Market_{Euro} \rightarrow Market_i$)										
Statistics $_{(Euro,\,i)}$	2.6406	1.6344	1.2338	1.1948	1.0537	0.6724	1.3453	4.8599	2.8982	3.8442
Status $_{(Euro,\,i)}$	Volatile	Stable	Stable	Stable	Stable	Stable	Stable	Volatile	Volatile	Volatile
Stability Test ($Market_{Euro} \leftarrow Market_i$)										
Statistics $_{(i,\,Euro)}$	4.6871	1.4137	3.9653	1.8469	0.7706	0.0547	0.3921	0.1091	163.4568	0.2161
Status $_{(i,\,Euro)}$	Volatile	Stable	Volatile	Stable	Stable	Stable	Stable	Stable	Volatile	Stable

5.2. The introduction of the Euro

As highlighted earlier in the paper, the introduction of the euro bought about a phase of improved environment in the Eurozone financial markets as illustrated by (Danthine *et al.*, 2000; Trichet, 2001). However, as Galati &Tsatsaronis (2003) notes the impact was uneven across the spectrum of the Eurozone financial markets. Nevertheless, EMU did have a huge impact on the integration of the European financial markets, especially within the Eurozone as illustrated by (Fratzscher, 2001; Baele *et al.*, 2004; Lane & Walti, 2006).

On another note, the impact from other events should not be overlooked; especially the war on terror which was initiated by the September 2001 attacks see (Chen & Siems, 2004; Johnston & Nedelescu, 2006) and the accountancy issues of 2002 which led to the bankruptcy of Enron and WorldCom see (Benston & Hartgraves, 2002; Sidak, 2003; Brickey, 2002).

As illustrated by Table **3**, the advent of the Euro reduced the impact of news from the EuroStoxx on the Eurozone markets to five markets: DAX, ATHEX, ISEQ, PSI and IBEX. However, the impact of news from the Eurozone markets on the EuroStoxx did increased to five markets: ATX, BEL, OMXH, CAC and AEX. Thus the ratio for both news routes is 5:6.

With the exception of the (ATX, BEL, OMXH AEX and PSI), there was volatility spillover effect between the EuroStoxx and Eurozone market meaning a volatility transmission ratio of 6:5. However, the volatility spillover effect from the Eurozone markets to the EuroStoxx was less significant with only four markets being affected: ATX, CAC, DAX and AEX; giving a ratio of 4:7.

The results seem to be hinting at the EuroStoxx transmitting bad news to six Eurozone markets: BEL, OMXH, CAC, DAX, MIB and AEX; thus indicating a ratio of 6:5. Conversely, the transmission of bad news to EuroStoxx point to five Eurozone markets: BEL, DAX, ATHEX, AEX and IBEX giving a ratio of 5:6.

The stability status of the transmission between the EuroStoxx and Eurozone markets seem to be hinting at a ratio of 8:3 with three markets being volatile: ATX, CAC and AEX. Whereas the stability status of the transmission from the Eurozone markets to EuroStoxx is hinting at a ratio of 9:2 with only the ATX and AEX being volatile.

Table 3. *Stability Test for Euro Introductory Period (01/01/1999 - 11/03/2003)*

Market	*ATX*	*BEL 20*	*OMX H 25*	*CAC 40*	*DAX*	*ATHEX LC*	*ISEQ Overall*	*MIB*	*AEX*	*PSI 20*	*IBEX 35*
Distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	GED	t-Student	Normal
Mean Statistics											
μ_{Euro}	1.8252E-01	1.4888E-01	1.4110E-01	1.5519E-01	1.5313E-01	1.8019E-01	1.6551E-01	1.3417E-01	1.3906E-01	1.5414E-01	1.5393E-01
	(7.867E-03)	(6.998E-03)	(7.656E-03)	(7.554E-03)	(4.139E-03)	(9.692E-03)	(6.451E-03)	(6.953E-03)	(6.565E-03)	(5.883E-03)	(7.585E-03)
μ_i	4.6904E-03	2.6802E-02	1.3354E-02	2.1369E-01	3.5177E-01	1.1734E+00	1.1992E-01	1.4151E+00	2.2808E-03	2.9903E-01	7.5780E-01
	(2.440E-06)	(2.350E-03)	(1.396E-03)	(1.139E-02)	(6.991E-04)	(7.584E-02)	(9.560E-05)	(9.810E-02)	(1.298E-04)	(1.655E-02)	(3.360E-02)
Off Diagonal Co-Variance Statistics											
$A_{Euro, i}$	4.7540E-03	1.8235E-02	-5.3600E-03	-8.5587E-02	4.6463E-01	3.3138E-01	1.8626E-01	8.1012E-02	2.5535E-03	2.2861E-01	1.7249E-01
	(5.859E-04)	(6.076E-03)	(3.339E-03)	(8.764E-02)	(8.680E-02)	(1.975E-01)	(2.020E-02)	(3.579E-01)	(5.108E-04)	(5.895E-02)	(1.279E-01)
$A_{i, Euro}$	2.0066E+00	5.2074E-01	3.5355E-01	1.4034E-01	3.0446E-02	4.2181E-04	4.6515E-02	1.8756E-02	6.0038E+00	1.7293E-02	2.9867E-02
	(4.803E-01)	(6.693E-02)	(3.447E-02)	(3.868E-02)	(1.477E-02)	(2.306E-04)	(1.342E-02)	(2.958E-03)	(2.288E+00)	(4.728E-03)	(5.768E-03)
$B_{Euro, i}$	-4.6450E-03	-9.2278E-04	1.3913E-02	-9.1728E-01	4.8271E-01	-3.5863E-01	-1.2253E-01	1.8753E+00	1.8722E-03	-9.2672E-03	-1.5536E+00
	(1.178E-03)	(8.106E-03)	(4.359E-03)	(1.292E-01)	(1.078E-01)	(3.531E-01)	(5.028E-02)	(7.457E-01)	(6.672E-04)	(6.524E-02)	(2.651E-01)
$B_{i, Euro}$	2.7084E+00	5.0942E-02	-9.3450E-02	2.6438E-01	-1.0712E-01	2.7433E-04	4.7274E-02	-2.3768E-03	-3.6474E+01	8.8741E-03	9.8045E-03
	(7.156E-01)	(7.082E-02)	(3.050E-02)	(5.818E-02)	(3.467E-02)	(2.337E-04)	(2.595E-02)	(4.772E-03)	(2.438E+00)	(6.050E-03)	(8.634E-03)
$D_{Euro, i}$	2.6443E-02	-5.8937E-05	-5.0000E-09	-4.7228E-01	-1.1603E+00	1.1339E+01	1.2842E+00	-5.1636E+00	-3.1791E-03	1.9384E+00	6.1840E+00
	(6.750E-03)	(3.144E-01)	(6.113E-02)	(6.798E-01)	(7.285E-01)	(2.628E+00)	(1.628E-01)	(3.550E+00)	(3.604E-03)	(9.347E-01)	(9.942E-01)
$D_{i, Euro}$	3.1656E+01	-1.5430E-03	1.2500E-07	1.2236E-01	-2.2348E-02	-7.0240E-02	3.5434E-01	2.4081E-03	-5.1675E+01	3.2060E-01	-6.1823E-02
	(5.756E+00)	(8.231E+00)	(1.534E+00)	(2.386E-01)	(1.455E-01)	(2.399E-02)	(2.623E-01)	(2.070E-02)	(1.432E+01)	(2.116E-01)	(5.292E-02)
Model Statistics											
Log-Likelihood	3,587.0507	1,144.9582	1,202.1530	492.5994	-320.1671	-3,933.0375	-55.2916	-2,299.9445	5,302.0649	-965.6877	-1,485.9866
Final Criterion	0.00E+00	0.00E+00	2.00E-07	2.90E-06	0.00E+00	7.20E-06	0.00E+00	1.80E-06	8.00E-06	1.70E-06	3.10E-06
Co-integration Volatility Test											
σ^2_{Euro}	0.406660										
σ^2_{Market}	0.015024	0.218365	0.340313	0.642757	0.861218	33.759090	0.585550	5.335929	0.007623	2.250696	2.319631
Stability Test ($Market_{Euro} \rightarrow Market_i$)											
Statistics	2.3085	1.5723	1.3273	2.3586	0.9567	0.3018	0.3506	0.7326	2.4108	0.4357	1.3949
Status	Volatile	Stable	Stable	Volatile	Stable	Stable	Stable	Stable	Volatile	Stable	Stable
Stability Test ($Market_{Euro} \leftarrow Market_i$)											
Statistics	83.8807	0.6877	0.9905	0.4507	0.8668	0.0313	0.5562	0.1709	200.6969	0.2458	0.3749
Status	Volatile	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Volatile	Stable	Stable

Note: PSI 20 start 11/01/1999

5.3. Mid 2000s Global bull market

In accordance with Pagan & Sossounov (2003), we set a trend to be a financial market period of four or more month. Thus, allowing us to identify the mid-2000s global bull equity market to be between March 2003 and October 2007 using the monthly MCSI World index obtained from investing.com. Furthermore, this observation seems to match the trend in the monthly EuroStoxx 50 index as illustrated by Figure 1.

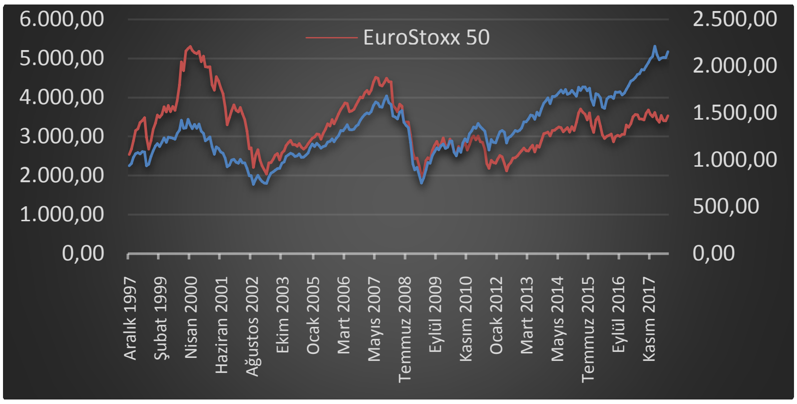

Figure 1. *Trends in Global and Eurozone Equities Markets*

However, another key factor shaping the financial markets in the mid-2000s was the housing bubble primarily in the US which started in 2002 according to Baker (2008). This led to the increase in Mortgage Backed Securities and Collateralized Debt Obligationas hinted by Masood (2009). As hinted by Fender & Kiff (2004), these securities were by their nature complicated to understand and rate. Furthermore, according to Masood (2009), these securities included subprime mortgages which offered a high positive spread with respect to the yields offered by most governments' bonds mainly due to the inherent high risks.

In addition, as highlighted previously, the continuation of "war on terror" was a key issue with the invasion of Afghanistan and Iraq as illustrated by (Johnston & Nedelescu, 2006; Fernandez, 2008).

During the mid-2000s global bull market, news from the EuroStoxx impacted only three Eurozone markets: CAC, ATHEX and IBEX as noted by Table 4. Furthermore, news from only four Eurozone markets had an impact on the EuroStoxx: ATX, BEL, OMXH and AEX. Therefore giving ratios 3:8 and 4:7 respectively.

With the exception of the (ATX, OMXH AEX and PSI), there was volatility spillover effect between the EuroStoxx and Eurozone markets indicating a ratio of 7:4. However, there was a volatility spillover effect from five Eurozone markets to the EuroStoxx: BEL, OMXH, CAC, ISEQ and AEX. This would hint at a ratio of 5:6.

The results seem to be hinting at the EuroStoxx transmitting bad news to three Eurozone markets: OMXH, AEX and IBEX. Conversely, the transmission of bad news to EuroStoxx point to four Eurozone markets:

OMXH, DAX, PSI and IBEX. Moreover hinting at ratios of 3:8 and 4:7 respectively.

The stability status of the transmission between the EuroStoxx and Eurozone markets seem to be hinting at a ratio of 6:5 with five markets being volatile: BEL, OMXH, DAX, AEX and IBEX. Yet, the stability status of the transmission from the Eurozone markets to EuroStoxx is hinting at a ratio of 5:6 with the ATX, OMXH, CAC, DAX, AEX and PSI being volatile.

Table 4.*Stability Test for Mid-2000s Global Bull Market Period (12/03/2003 - 07/06/2007)*

Market	*ATX*	*BEL 20*	*OMX H 25*	*CAC 40*	*DAX*	*ATHEX LC*	*ISEQ Overall*	*MIB*	*AEX*	*PSI 20*	*IBEX 35*
Distribution	Normal	Normal	Normal	t-Student	Normal	Normal	Normal	t-Student	t-Student	Normal	t-Student
						Mean Statistics					
μ_{Euro}	2.8179E-02	2.5382E-02	2.5183E-02	2.5341E-02	2.4339E-02	3.1600E-02	3.9000E-02	1.7084E-02	2.3764E-02	3.6367E-02	2.4057E-02
	(1.699E-03)	(1.410E-03)	(1.536E-03)	(1.057E-03)	(1.400E-03)	(1.954E-03)	(1.733E-03)	(8.304E-04)	(9.356E-04)	(1.651E-03)	(1.046E-03)
μ_i	8.7332E-03	1.0806E-02	7.9069E-03	4.4584E-02	6.4174E-02	9.7231E-01	8.1666E-02	1.0390E+00	3.6375E-04	4.5643E-02	1.7456E-01
	(6.749E-04)	(4.482E-05)	(5.228E-04)	(1.823E-03)	(3.484E-03)	(8.125E-02)	(3.580E-03)	(5.560E-02)	(1.396E-05)	(3.409E-03)	(7.162E-03)
						Off Diagonal Co-Variance Statistics					
$A_{Euro,i}$	8.4322E-03	7.1397E-02	2.4996E-03	1.3745E-01	8.3948E-02	1.2917E+00	6.2738E-03	-3.7205E-04	2.2310E-03	1.0155E-02	3.8146E-01
	(4.068E-03)	(2.509E-02)	(7.366E-03)	(1.593E-01)	(9.174E-02)	(5.074E-01)	(4.511E-02)	(8.567E-01)	(8.160E-04)	(3.699E-02)	(2.694E-01)
$A_{i,Euro}$	1.6481E-01	3.9793E-01	3.4202E-01	6.5284E-02	6.1610E-02	2.9739E-03	-7.8290E-03	-1.0430E-05	4.7370E+00	2.4023E-02	-1.1681E-03
	(1.417E-02)	(4.434E-02)	(4.564E-02)	(5.524E-02)	(1.463E-02)	(4.129E-04)	(4.685E-03)	(3.940E-06)	(2.512E+00)	(5.122E-03)	(2.718E-03)
$B_{Euro,i}$	4.0547E-03	-2.8218E-01	-6.1637E-02	5.6985E-01	-2.0216E-01	6.5935E-01	-2.4951E-01	-3.7671E-01	-1.5034E-03	2.6707E-02	-5.5080E-01
	(4.930E-03)	(5.596E-02)	(7.153E-03)	(1.688E-01)	(1.428E-01)	(6.011E-01)	(6.414E-02)	(3.408E-01)	(1.391E-03)	(3.377E-02)	(3.018E-01)
$B_{i,Euro}$	5.0791E-02	4.9401E-01	2.3582E-01	-2.2975E-01	-1.4657E-02	-8.4500E-06	1.2306E-01	-6.3000E-07	7.4661E+00	7.1277E-03	8.7832E-03
	(1.209E-02)	(1.209E-01)	(5.493E-02)	(6.086E-02)	(2.810E-02)	(4.258E-04)	(4.675E-03)	(1.680E-06)	(4.293E+00)	(4.590E-03)	(4.031E-03)
$D_{Euro,i}$	7.6479E-01	3.4302E-01	-2.0205E-02	9.4788E-01	1.3840E-06	8.4700E-06	1.6924E+00	9.4636E+01	-6.5039E-03	3.2132E-02	-4.8602E+00
	(1.027E-01)	(2.086E-01)	(1.566E-01)	(1.051E+00)	(9.515E-01)	(1.140E+01)	(3.758E-01)	(6.180E+01)	(1.148E-02)	(4.763E-01)	(5.422E+00)
$D_{i,Euro}$	4.7651E+00	5.2221E-01	-1.5219E+00	2.5993E-01	-2.4000E-08	0.0000E+00	1.9882E-01	1.1085E-02	6.7994E+00	-3.8397E-01	-1.5832E-02
	(9.462E-01)	(8.853E-01)	(1.027E+00)	(3.249E-01)	(1.676E-01)	(8.738E-03)	(8.170E-02)	(1.277E-02)	(3.035E+01)	(2.041E-01)	(4.284E-02)
						Model Statistics					
Log-Likelihood	3,430.6909	3,971.7453	4,429.3204	4,379.5326	3,220.4664	-948.3656	1,743.7585	-403.4603	9,147.5749	1,824.7063	1,958.1198
Final Criterion	6.00E-07	9.10E-06	6.40E-06	8.50E-06	2.90E-06	3.20E-06	4.10E-06	3.70E-06	7.00E-07	2.10E-06	1.30E-06
						Co-integration Volatility Test					
σ^2_{Euro}	0.125478										
σ^2_{Market}	0.254822	0.129432	0.069595	0.226895	0.295208	6.676128	0.688531	377.490365	0.002580	0.515531	1.147335
						Stability Test (Market$_{Euro}$→Market$_i$)					
Statistics	0.5856	3.4042	5.5330	1.8593	2.6581	0.1398	0.5518	0.2470	7.8541	1.4524	4.7372
Status	Stable	Volatile	Volatile	Stable	Volatile	Stable	Stable	Stable	Volatile	Stable	Volatile
						Stability Test (Market$_{Euro}$←Market$_i$)					
Statistics	10.4671	1.6247	9.9658	2.5670	2.2655	0.1466	0.8427	0.0026	140.5812	2.1104	0.7921
Status	Volatile	Stable	Volatile	Volatile	Volatile	Stable	Stable	Stable	Volatile	Volatile	Stable

5.4. Global financial crises

The global financial crisis started with the subprime mortgages in the US and quickly enveloped the global financial sector. By mid-2007, a number of international banks (e.g. Bear Stearns and BNP Paribas) recorded losses on their off-balance sheet activities associated with the MBS or CDO securities, which resulted in flights to liquidity and quality. This quickly enveloped the global financial sector including many European banks such as Credit Agricole and Deutsche Bank. As the global financial crisis spread, the credit market froze therefore corporations could not find the money required and hence the crisis spread to the equity and corporate bonds market. For further in-depth research and analysis on the crises see (Brunnermeier, 2009; Caballero & Krishnamurthy, 2009; Masood, 2009) amongst others. Conversely, it is important to analyse the equity market during the global financial crisis. A by-product of such a global financial crisis is the inevitable deep recession which for the Eurozone was between 2008 Q1 and 2009 Q2, however some countries in the Eurozone were affected more than others i.e. the GIPS nations.

During the global financial crisis, with the exceptions of three markets (BEL, ISEQ and AEX); news from EuroStoxx impacted the Eurozone markets as Table 5 points. Yet, news from only two Eurozone markets had an impact on the EuroStoxx: BEL and AEX. Hence indicating ratios of 8:3 and 2:9 respectively.

With the exception of the (DAX and AEX), there was volatility spillover effect between the EuroStoxx and Eurozone markets indicating a ratio of 9:2. However, there was a volatility spillover effect from four Eurozone markets to the EuroStoxx: BEL, OMXH, CAC and AEX. Therefore giving a ratio of 4:7.

The results seem to be hinting at the EuroStoxx transmitting bad news to two Eurozone markets: OMXH and ATHEX meaning a ratio of 2:9. Conversely, the transmission of bad news to EuroStoxx point to four Eurozone markets: BEL, DAX, ISEQ and PSI hinting at a 4:7 ratio.

Table 5. *Stability Test for Global Financial Crises Period (08/06/2007 - 05/11/2009)*

Market	*ATX*	*BEL 20*	*OMX H 25*	*CAC 40*	*DAX*	*ATHEX LC*	*ISEQ Overall*	*MIB*	*AEX*	*PSI 20*	*IBEX 35*
Distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	GED	t-Student	Normal	t-Student
						Mean Statistics					
μ_{Euro}	1.0306E-01	9.3310E-02	1.1560E-01	9.2224E-02	9.9391E-02	1.1885E-01	9.1467E-02	7.9555E-02	8.2856E-02	1.1402E-01	8.3285E-02
	(1.051E-02)	(6.749E-03)	(6.117E-03)	(7.933E-03)	(1.209E-04)	(6.056E-03)	(6.809E-03)	(7.591E-03)	(4.614E-03)	(5.490E-03)	(4.383E-03)
μ_i	1.3520E-01	4.5951E-02	8.1944E-02	1.6728E-01	3.8709E-01	4.0273E+00	1.2301E-01	6.3790E+00	9.1593E-04	4.2448E-01	1.1301E+00
	(1.640E-02)	(5.042E-03)	(4.351E-03)	(1.306E-02)	(8.073E-03)	(7.344E-03)	(1.263E-02)	(4.612E-01)	(4.941E-05)	(2.449E-02)	(6.337E-02)
						Off Diagonal Co-Variance Statistics					
$A_{Euro,\,i}$	1.6405E-01	-2.6559E-02	1.2682E-01	1.4315E-01	4.8452E-01	3.5128E+00	6.2091E-02	6.0859E+00	1.0901E-04	1.0367E-01	1.4484E+00
	(6.181E-02)	(3.285E-02)	(2.691E-02)	(1.979E-01)	(6.311E-02)	(1.102E+00)	(9.051E-02)	(5.146E+00)	(9.727E-04)	(2.140E-01)	(7.615E-01)
$A_{i,\,Euro}$	7.6418E-02	2.0537E-01	-3.3607E-02	6.7159E-02	1.1676E-02	2.2338E-03	2.5186E-02	1.9633E-03	9.6908E+00	1.9035E-02	1.0073E-02
	(2.577E-02)	(3.590E-02)	(6.888E-02)	(5.052E-02)	(6.375E-03)	(5.879E-04)	(4.321E-03)	(8.036E-04)	(2.848E+00)	(4.017E-03)	(4.660E-03)
$B_{Euro,\,i}$	1.9014E-01	3.6701E-01	-1.5753E-01	-2.5126E+00	-3.3933E-02	1.4576E+00	2.2907E-01	-2.8125E+01	1.6861E-03	2.2507E+00	-2.2166E+00
	(3.335E-01)	(6.256E-02)	(2.863E-02)	(1.846E-01)	(3.272E-01)	(1.561E+00)	(1.152E-01)	(7.401E+00)	(9.355E-04)	(3.333E-01)	(9.632E-01)
$B_{i,\,Euro}$	-9.9805E-02	-3.3214E-01	2.5727E-01	6.5892E-01	-7.3459E-02	-1.7825E-03	-4.1211E-03	8.0086E-03	-5.4876E-01	-4.0419E-02	1.7872E-02
	(1.200E-01)	(4.762E-02)	(9.630E-02)	(6.167E-02)	(1.806E-02)	(8.737E-04)	(3.599E-03)	(7.816E-04)	(3.406E+00)	(4.894E-03)	(6.184E-03)
$D_{Euro,\,i}$	4.2000E-08	4.3180E-01	-3.4880E-01	6.1678E-01	9.6932E-01	-3.6223E+01	2.2373E+00	2.9644E+01	1.7578E-02	1.6400E-07	1.0852E+01
	(3.133E-01)	(2.684E-01)	(2.116E-01)	(6.747E-01)	(1.293E+00)	(8.189E+00)	(9.615E-01)	(3.359E+01)	(6.357E-03)	(1.115E+00)	(5.358E+00)
$D_{i,\,Euro}$	5.6000E-07	-3.2998E-02	1.4771E+00	1.4696E-01	-3.4274E-01	2.0133E-02	-7.5545E-01	2.9785E-03	2.0524E+01	-1.1000E-08	6.8087E-02
	(2.595E-01)	(5.810E-01)	(2.993E-01)	(2.590E-01)	(7.854E-02)	(6.933E-03)	(2.929E-01)	(4.941E-03)	(7.114E+01)	(1.003E-01)	(2.485E-02)
						Model Statistics					
Log-Likelihood	300.6691	742.1833	931.2756	798.1102	264.2771	-1,865.7951	-377.1802	-1,786.5661	3,652.2827	-591.0954	-621.9875
Final Criterion	4.10E-06	8.90E-06	8.60E-06	2.30E-06	0.00E+00	3.70E-06	2.80E-06	9.00E-06	3.30E-06	3.00E-06	0.00E+00
						Co-integration Volatility Test					
σ^2_{Euro}	0.452223										
σ^2_{Market}	0.630372	0.419485	0.190188	0.744926	1.633878	17.450001	1.692385	29.480684	0.006635	3.083772	6.090440
						Stability Test ($Market_{Euro} \rightarrow Market_i$)					
Statistics	0.5965	0.2613	2.1474	2.2993	0.2013	1.8016	0.7127	0.2207	2.1371	0.3830	1.3884
Status	Stable	Stable	Volatile	Volatile	Stable	Stable	Stable	Stable	Volatile	Stable	Stable
						Stability Test ($Market_{Euro} \leftarrow Market_i$)					
Statistics	0.9453	1.3305	1.0909	0.1061	0.6733	0.0547	0.8087	0.0330	62.4718	0.2889	0.1382
Status	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Volatile	Stable	Stable

The stability status of the transmission between the EuroStoxx and Eurozone markets seem to be hinting at a ratio of 8:3 with three markets being volatile: OMXH, CAC and AEX, Conversely, the stability status of the transmission from the Eurozone markets to EuroStoxx is hinting at a ratio of 10:1 with only the AEX being volatile.

5.5. Sovereign debt crisis

The sovereign debt crisis started with the Greek revision of the deficit statistics on 5th November 2009, gradually becoming a wide spread issue of confident in global fiscal policies enveloping a number of Eurozone nations especially the GIPS nations as illustrated by (Schwarcz, 2011; Metiu, 2011; Mohl & Sondermann, 2013). The crisis reached the US with the deficit/debt ceiling crises which closed the US federal government, see (Aye *et al.*, 2016; Nippani & Smith, 2014). The impact from the sovereign debt crisis led to a double dip recession in the Eurozone from 2011 Q3 to 2013 Q1, although for some Eurozone countries this was just a continuation of the recession that followed the global financial crisis.

During the sovereign debt crisis, news from EuroStoxx impacted eight Eurozone markets; with the exception of the BEL, ISEQ and AEX, every Eurozone market was affected as hinted by Table 6. Yet, news from only two Eurozone markets had an impact on the EuroStoxx: BEL and AEX. Surprisingly, the news transmission did not involve the GIPS markets. However, the ratios do tell a varied story with 8:3 and 2:9 respectively.

With the exception of the AEX and PSI, there was volatility spillover effect between the EuroStoxx and Eurozone markets indicating a ratio of 9:2. However, there was a volatility spillover effect from five Eurozone markets to the EuroStoxx: ATX, BEL, OMXH, CAC and AEX. Thus meaning a ratio of 5:6.

The results seem to be hinting at the EuroStoxx transmitting bad news to five Eurozone markets: ATX, OMXH, CAC, ISEQ and PSI. Conversely, there was transmission of bad news to EuroStoxx from the OMXH, CAC, DAX and ATHEX markets. This seem to be indicating ratios of 5:6 and 4:7 respectively.

The stability status of the transmission between the EuroStoxx and Eurozone markets seem to be hinting at a ratio of 3:8 with eight markets being volatile: ATX, BEL, OMXH, CAC, ISEQ, AEX, PSI and IBEX. Conversely, the stability status of the transmission from the Eurozone markets to EuroStoxx is hinting at a ratio of 8:3 with the OMXH, CAC and AEX being volatile.

Table 6. *Stability Test for Eurozone Sovereign Debt Crises Period (06/11/2009 - 23/05/2014)*

Market	*ATX*	*BEL 20*	*OMX H 25*	*CAC 40*	*DAX*	*ATHEX LC*	*ISEQ Overall*	*MIB*	*AEX*	*PSI 20*	*IBEX 35*
Distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Mean Statistics											
μ_{Euro}	4.2214E-02	4.3411E-02	4.4181E-02	4.0793E-02	3.7419E-02	4.5479E-02	4.6584E-02	3.8975E-02	3.8686E-02	4.4333E-02	4.4682E-02
	(7.597E-05)	(1.916E-03)	(2.037E-03)	(1.758E-03)	(1.746E-03)	(2.039E-03)	(2.130E-03)	(1.764E-03)	(1.848E-03)	(2.000E-03)	(1.820E-03)
μ_i	4.1706E-02	2.6321E-02	3.8216E-02	7.5143E-02	2.3663E-01	3.4170E-01	5.7336E-02	2.5418E+00	4.1851E-04	1.6396E-01	6.3992E-01
	(1.538E-03)	(1.307E-03)	(1.789E-03)	(3.302E-03)	(1.213E-02)	(1.689E-02)	(2.833E-03)	(1.091E-01)	(2.246E-05)	(1.215E-02)	(2.675E-02)
Off Diagonal Co-Variance Statistics											
$A_{Euro, i}$	1.0900E-01	3.6479E-02	1.0474E-01	2.0161E-01	5.2311E-01	7.8490E-01	7.2979E-02	1.3068E+00	1.1437E-03	6.7880E-01	-9.5931E-01
	(2.443E-02)	(2.921E-02)	(2.035E-02)	(1.406E-01)	(1.469E-01)	(1.349E-01)	(2.385E-02)	(2.028E+00)	(3.746E-04)	(1.158E-01)	(5.145E-01)
$A_{i, Euro}$	9.8249E-02	1.8070E-01	7.9670E-02	9.1798E-02	1.0966E-03	2.2790E-03	4.8118E-02	3.1065E-03	7.7313E+00	2.7663E-02	1.2245E-02
	(2.704E-02)	(5.300E-02)	(2.756E-02)	(4.066E-02)	(4.932E-03)	(6.294E-04)	(1.413E-02)	(4.503E-04)	(3.281E+00)	(2.945E-03)	(1.613E-03)
$B_{Euro, i}$	-2.7845E-01	-2.3045E-01	-2.5995E-01	-5.7131E-01	-1.5299E-01	-8.0178E-01	-2.2053E-01	-1.6886E+01	-3.1681E-04	5.0368E-02	1.1253E+01
	(4.339E-02)	(6.853E-02)	(2.800E-02)	(2.026E-01)	(1.541E-01)	(1.934E-01)	(3.398E-02)	(5.171E+00)	(6.616E-04)	(1.721E-01)	(8.378E-01)
$B_{i, Euro}$	2.0417E-01	4.8208E-01	-1.3146E-01	-1.5341E-01	9.0305E-03	1.5469E-03	2.0764E-02	2.2508E-03	1.3918E+01	7.4351E-03	-2.4606E-02
	(4.275E-02)	(1.589E-01)	(0.000E+00)	(6.510E-02)	(4.775E-03)	(6.042E-04)	(2.060E-02)	(1.467E-03)	(4.377E+00)	(3.696E-03)	(2.920E-03)
$D_{Euro, i}$	-2.8138E-01	7.3576E-02	-1.6930E-06	-5.1480E-06	2.1350E-06	2.1350E-06	-1.7266E-01	2.5327E+01	0.0000E+00	-3.9973E+00	3.9239E-01
	(2.450E-01)	(1.813E-01)	(1.607E-01)	(7.397E-01)	(1.151E+00)	(1.151E+00)	(2.825E-01)	(1.449E+01)	(2.811E-03)	(1.175E+00)	(1.983E+01)
$D_{i, Euro}$	1.0298E+00	5.0410E-01	-2.9590E-06	-3.4610E-05	-1.1000E-07	-1.1000E-07	5.0595E-01	1.5599E-02	2.9000E-07	1.1728E-02	1.5643E-03
	(1.603E-01)	(6.086E-01)	(2.612E-01)	(3.537E-01)	(3.188E-02)	(3.188E-02)	(1.979E-01)	(3.061E-03)	(2.944E+01)	(6.312E-02)	(8.010E-02)
Model Statistics											
Log-Likelihood	3,260.4049	4,034.0831	3,431.8634	3,571.6650	1,365.2570	-349.4377	2,686.5624	-1,375.5705	8,904.9819	764.7998	109.0727
Final Criterion	1.60E-06	1.70E-06	2.00E-06	0.00E+00	9.00E-07	5.10E-06	6.70E-06	4.60E-06	1.20E-06	7.20E-06	6.90E-06
Co-integration Volatility Test											
σ^2_{Euro}	0.162061										
σ^2_{Market}	0.173969	0.111005	0.120255	0.296825	1.044217	4.723441	0.203134	10.875993	0.001786	1.179788	3.082813
Stability Test ($Market_{Euro} \rightarrow Market_i$)											
Statistics	4.3176	4.1030	4.0919	2.9848	0.5222	0.2081	3.6151	0.7926	6.0982	3.1808	2.9849
Status	Volatile	Volatile	Volatile	Volatile	Stable	Stable	Volatile	Stable	Volatile	Volatile	Volatile
Stability Test ($Market_{Euro} \leftarrow Market_i$)											
Statistics	0.9885	0.6112	3.7256	2.3135	0.8206	0.2039	1.1642	0.0887	126.0313	0.7103	0.3115
Status	Stable	Stable	Volatile	Volatile	Stable	Stable	Stable	Stable	Volatile	Stable	Stable

5.6. Rise of populist movement

A key issue facing any further integration of the Eurozone is the rise of the populist right-wing movement. As hinted by Weyland (2001), traditionally populism has been defined as a cumulative concept, characterized by the simultaneous presence of political, economic, social, and discursive attributes. However, as hinted by a number of articles including (Mudde, 2004; Mudde & Kaltwasser, 2013; Jansen, 2011) populism is difficult to define. Indeed, as with any ism word it is hard to conceptualised as stated by Jansen (2011) leading to Mudde (2004, p.542) to state the following" *Definingthe Undefinable*". Many authors have used different definition depending on their writings. Mudde (2004) defines populism as

> "an ideology that considers society to be ultimately separated into two homogeneous and antagonistic groups, 'the pure people' versus 'the corrupt elite', and which argues that politics should be an expression of the volonté générale (general will) of the people."

Whichever definition you used, the rise of the populist movement is seen as a threat to the further integration of the EU and Eurozone economies and financial markets as hinted by Polyakova & Fligstein (2016), Fligstein *et al.*, (2012), Guiso *et al.*, (2018) and Luo (2017). The underlying influences of the Brexit results and prospective Italexit have been attributed to the populist movement in both the UK and Italy caused by deep issues as illustrated by (Inglehart & Norris, 2016; Hobolt, 2016; Codogno & Galli, 2017). In particular as the Franco-German axis is the driving force behind European integration, the rise in popularity and strength of National Rally (an anti-Integration party) in France would be seen as a weakness in the future push to further integration. And as put by Luo (2017, p.407) "*The growth of Eurosceptism in major EU members thus has resulted in political instability to European integration.*" Moreover, as implied by Luo (2017), the European Parliament elections in May 2014 was a watershed event for this rise. Although, many like Mudde[6] and Mudde (2016), disagree with the significant of the 2014 European Parliament elections. Yet we use the day after the 2014 European Parliament elections, 26 May 2014, as the start date of our observation.

Furthermore, the continued impact of the Brexit vote on the Eurozone equity markets as the UK and EU struggle to get a workable agreement that would suit both sides and more importantly get approval from both parliaments. According to Hobolt (2016), in the wake of the 23 June 2016 Brexit vote global equity markets loss over two trillion dollars. The reaction on 24th June 2016 of the Eurozone equity markets illustrated the shock wave to the Brexit vote as shown by Figure 2. With the exception of Finland, the losses were greater than 5% meaning an average of 8.17% across all 12 observed Eurozone equity markets. With the current draft agreement[7] in the balance, the continued disfunction at the heart of the British government look likely to negatively impact on the global and hence the Eurozone equity markets in the short run.

Moreover, an additional impact on the integration of the Eurozone came on 1st October 2017 when Catalonia held a referendum on independence from Spain as highlighted by Cetra & Lineira (2018). According to Cetra & Lineira (2018), the turnout was only 43% resulting in a 90.2% vote for independence against 7.8%. The Spanish government declared the referendum illegal. However, as stated by Cetra & Lineira (2018), this was not the only bid for independence within the European Union, in 2014 the UK government agreed a referendum on Scottish independence. The turnout was 99.91% resulting in a 55.3% win for the unionists. However, as argued by Cetra & Lineira (2018), with the Brexit results many in Scotland feel there is a need to hold a new referendum. Furthermore, according to Cetra & Lineira (2018), there are other regions within the EU and in particular the Eurozone who are calling for independence.

[6] In an article to the Washington Post on 30/05/2014 titled "The far right in the 2014 European Elections: of earthquakes, cartels and designer fascists."

[7] The draft agreement document number TF50 (2018) 55 agreed on 14 November 2018. the agreement could be accessed on [Retrieved from].

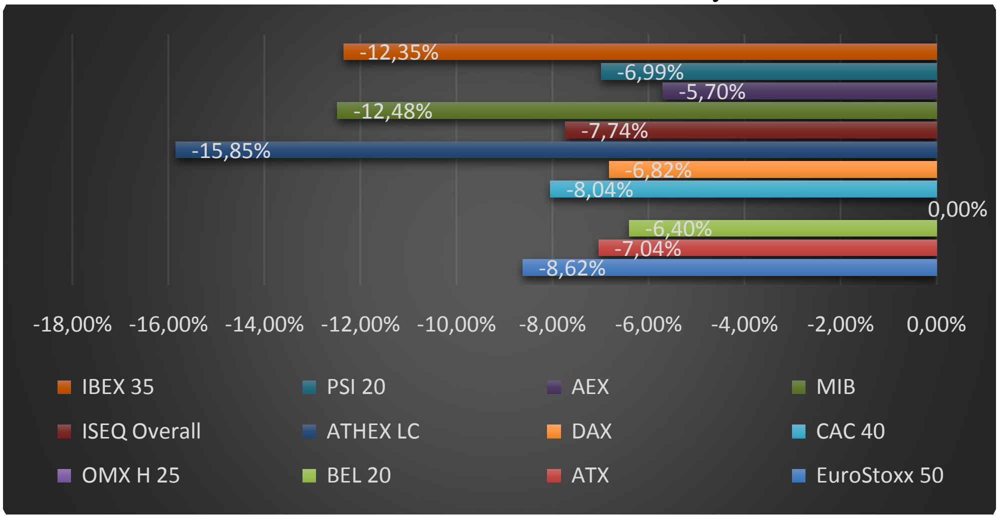

Figure 2. *Impact of Brexit Vote on the Eurozone Equity Markets on 24 June 2016*

Table 7 seem to be hinting at news from the EuroStoxx effecting seven markets during this period with the exception of the ATX, BEL, ATHEX and AEX, all the markets were effected. However, the news from only two markets, BEL and AEX, did have an impact on the EuroStoxx. Thus resulting in ratios of 7:4 and 2:9 respectively.

With the exception of four markets: ATX, BEL, OMXH and AEX; there was a volatility spillover effect between the EuroStoxx and Eurozone markets hinting at a ratio of 7:4. However, the transmission of volatility between the Eurozone markets and EuroStoxx impacted five markets: BEL, OMXH, CAC, ATHEX and AEX. Hence, the ratio was 5:6.

The statistics indicate a ratio of 7:4 effected by negative news from the EuroStoxx with the exceptions being the ATX, OMXH, ATHEX and PSI. With the exception of three Eurozone markets: OMXH, MIB and AEX; the EuroStoxx was effected by the transmission of negative news which gives a ratio of 8:3.

The stability status of the transmission between the EuroStoxx and Eurozone markets seem to be hinting at a ratio of 7:4 with seven markets being volatile: ATX, BEL, OMXH, CAC, DAX, MIB and AEX. Conversely, the stability status of the transmission from the Eurozone markets to EuroStoxx is hinting at a ratio of 6:5 with the ATX, BEL, OMXH, CAC, ATHEX and AEX being volatile.

Table 7. *Stability Test for the Rise of Populist Movement Period (26/05/2014-31/12/2018)*

Market	*ATX*	*BEL 20*	*OMX H 25*	*CAC 40*	*DAX*	*ATHEX LCISEQ Overall*	*MIB*	*AEX*	*PSI 20*	*IBEX 35*
Distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Mean Statistics										
μ_{Euro}	4.1771E-02	3.3660E-02	4.2091E-02	2.4358E-02	3.4035E-02	3.8468E-02	4.2687E-02	4.4956E-02	3.2119E-02	4.1652E-02	4.2365E-02
	(2.336E-03)	(2.115E-03)	(2.471E-03)	(2.513E-03)	(2.669E-03)	(2.549E-03)	(2.965E-03)	(1.970E-03)	(2.252E-03)	(2.425E-03)	(2.239E-03)
μ_i	2.5922E-02	2.6019E-02	4.8286E-02	4.6757E-02	4.4106E-01	2.9950E-03	1.4756E-01	2.6007E+00	4.7916E-04	6.3112E-02	4.4258E-01
	(1.303E-03)	(1.539E-03)	(2.492E-03)	(4.438E-03)	(2.811E-02)	(1.485E-04)	(6.979E-03)	(9.871E-02)	(3.508E-05)	(2.745E-04)	(2.167E-02)
Off Diagonal Co-Variance Statistics										
$A_{Euro,\ i}$	6.5956E-02	7.4354E-02	2.5277E-01	4.6829E-01	-1.3120E-01	1.4008E-02	2.4249E-01	3.7100E+00	6.3213E-04	1.3655E-01	2.2454E+00
	(1.296E-02)	(2.989E-02)	(2.878E-02)	(1.339E-01)	(5.078E-01)	(2.074E-02)	(6.206E-02)	(1.605E+00)	(7.406E-04)	(4.740E-02)	(3.840E-01)
$A_{i,\ Euro}$	7.0825E-02	2.2526E-01	-7.6780E-04	5.5285E-02	1.7186E-02	3.0693E-02	3.4760E-02	1.3161E-03	8.5865E+00	2.2882E-02	3.2391E-03
	(2.831E-02)	(4.011E-02)	(2.234E-02)	(2.971E-02)	(4.306E-03)	(8.795E-03)	(8.269E-03)	(4.971E-04)	(2.663E+00)	(4.679E-03)	(3.452E-03)
$B_{Euro,\ i}$	-9.8366E-02	9.6478E-02	-1.5693E-02	1.8777E+00	-6.7737E+00	-5.8065E-01	2.8419E-01	1.5017E+01	6.5862E-03	-3.1323E-01	-2.1523E+00
	(1.447E-02)	(5.499E-02)	(5.529E-02)	(2.663E-01)	(5.657E-01)	(3.171E-02)	(7.833E-02)	(3.471E+00)	(1.026E-03)	(6.020E-02)	(5.787E-01)
$B_{i,\ Euro}$	-6.3768E-02	-2.2701E-01	-2.7863E-01	-3.9242E-01	3.6006E-02	2.0875E-01	-9.7483E-03	-3.8105E-03	-1.8047E+01	2.3561E-02	2.4226E-03
	(3.200E-02)	(8.698E-02)	(4.425E-02)	(6.335E-02)	(4.649E-03)	(1.331E-02)	(1.236E-02)	(1.085E-03)	(3.638E+00)	(6.853E-03)	(4.240E-03)
$D_{Euro,\ i}$	2.0374E-01	-2.4470E-06	1.8480E-06	-2.9151E-05	-1.2676E-04	3.5310E-02	-6.2155E-02	-9.4102E+01	-9.0000E-08	1.0238E+00	-4.0354E-05
	(1.724E-01)	(2.238E-01)	(2.996E-01)	(8.773E-01)	(4.723E+00)	(1.635E-01)	(6.667E-01)	(1.271E+01)	(4.641E-03)	(5.597E-01)	(2.363E+00)
$D_{i,\ Euro}$	-8.8674E-01	-2.2260E-06	2.2700E-07	-1.0818E-05	-1.1050E-06	-3.9788E+00	-2.5844E-01	3.6774E-02	1.5700E-06	-4.8491E-02	-5.5900E-07
	(5.766E-01)	(4.216E-01)	(1.862E-01)	(2.247E-01)	(3.752E-02)	(6.380E+00)	(7.726E-02)	(4.498E-03)	(2.084E+01)	(1.372E-01)	(3.029E-02)
Model Statistics										
Log-Likelihood	3,268.6108	3,351.5086	2,640.4200	3,063.0282	503.8979	1,736.1457	1,282.4553	-1,796.3557	8,207.2039	1,236.5167	304.3198
Final Criterion	7.50E-06	0.00E+00	5.20E-06	7.30E-06	5.00E-07	8.80E-06	2.70E-06	3.70E-06	0.00E+00	3.90E-06	7.10E-06
Co-integration Volatility Test										
σ^2_{Euro}	0.208121									
σ^2_{Market}	0.118393	0.197020	0.184744	0.401641	1.976284	0.684980	1.194872	11.891184	0.003519	0.751496	2.286339
Stability Test (Market$_{Euro}$→Market$_i$)										
Statistics	2.9548	2.3091	2.1999	2.3877	3.6968	1.8079	0.3946	6.3365	5.9958	0.1674	0.3704
Status	Volatile	Volatile	Volatile	Volatile	Volatile	Stable	Stable	Volatile	Volatile	Stable	Stable
Stability Test (Market$_{Euro}$←Market$_i$)										
Statistics	6.7023	2.7898	3.6891	2.3721	0.4428	5.5952	0.9090	0.0801	63.1730	1.0969	0.4061
Status	Volatile	Volatile	Volatile	Volatile	Stable	Volatile	Stable	Stable	Volatile	Stable	Stable

6. Summary of the results

It is worth noting that theoretically in econometrics a fully integrated market news affecting one segment would affect all segments and hence the magnitude of the volatility spillover effect would be similar thru all segmentsas hinted by Baele (2005) and Bekaert *et al.*, (2002). In reality the markets do react differently to news depending on the affinity of the market's participants to the event. In a market, such as the Eurozone, where there is a number of diverse factors influencing the behaviour of market participants in each segment; the reaction to news and thus magnitude of the volatility spillover effect is likely to differ between segments and thru time. The truth is that the impact of any event is connected to "time and space" and hence the gravitational pull of the reaction is determined by the close affiliation of the market participants to the event at any given time.

In analysing the complete picture, you get the impression the interaction between Eurozone equity markets is governed by the underlining context as illustrated by Table 8. Simply put, this means that the market environment is key to financial integration, hence market participants reaction to general market environmental factors determine the level and stability of the financial market integration. Furthermore, these environmental factors are influenced by the "time and space" effect. In essence, this means that market participants react differently to any news or event at any time given the market.

Table 8.*Statistical Ratios of Results*

Period	*Direction*	*Pre-Euro*	*Euro Introductory*	*Bull Market*	*Financial Crisis*	*Sovereign Debt Crisis*	*Populist Movement*
News Contagion	Euro → Market	8:2	5:6	3:8	8:3	8:3	7:4
	Euro ← Market	3:7	5:6	4:7	2:9	2:9	2:9
Volatility Spillover	Euro → Market	6:4	6:5	7:4	9:2	9:2	7:4
	Euro ← Market	4:6	4:7	5:6	4:7	5:6	5:6
Negative News Effect	Euro → Market	7:3	6:5	3:8	2:9	5:6	7:4
	Euro ← Market	2:8	5:6	4:7	4:7	4:7	8:3
SMPCH	Euro → Market	6:4	8:3	6:5	8:3	3:8	7:4
	Euro ← Market	7:3	9:2	5:6	10:1	8:3	6:5

As illustrated by Table 8, the behaviour of market participants varies depending on the market and event in time. Hence the general differences and similarities in reacting to varying events which is illustrated by the period of high uncertainties during the later part of the observation. There are several similarities and yet several differences in the reactions to the events during the financial and sovereign debt crises and populist movements period.

The funny thing is thateven though the Eurozone financial markets may react differently; yet in the overall scheme of things the evidence from the literature is that of integration, especially during the euro introductory and bull market periods. In truth the Eurozone equity markets were never truly integrated as dictated by the econometrics theories earlier in this section and illustrated by Table 8. However, this does not mean that the markets were never integrated in accordance to the definition of Baele *et al.*, (2004).

7. Conclusion

In this paper, we extended the volatility test to analyse the stability status of the integration of the Eurozone equity markets in the aftermath of the Euro by introducing a multivariate volatility test. The underlining model was a bivariate asymmetrical BEKK GARCH, allowing us to analyse the volatility spillover, news contagion effect and stability of the market environment during six different periods with differing impacts.

Surprisingly, our findings seem to be hinting at generally news and volatility seem to travel from the Eurozone to the sovereign equity market. Conversely, the results of our stable market pre-condition hypothesis seem to suggest generally with the exception of two observed periods, the underlining market environment is stable. Unsurprisingly the two exceptions occur when the markets either massively underreact as in the case of the bull market period or massively overreact as in the sovereign debt crisis within the Eurozone.

Our empirical results point to differences in the reaction of market participants which hints at the "time and space" effect. This seem to be suggesting that the Eurozone equity markets were never truly integrated in the sense of the econometrics definition. However, this does not mean that the Eurozone equity markets were not integrated in accordance with the definition of Baele *et al.* (2004). What is without doubt is the reactions of market participants depends on two factors: the time and market of the eventas illustrated earlier, hence the "time and space" effect. This is what drives the Eurozone equity market's integration, especially during highly volatile and uncertain times.

A relevant factor raised by our empirical evidence regarding the stability of some markets during highly volatile periods is they seem to be defying conventional wisdom by being stable, in particular the Greek market during the sovereign debt crisis. As hinted by Fakhry (2016b), a possible explanation could be found in the underreaction / overreaction hypothesis which suggests that market participants' reaction leads to overvaluation or undervaluation during any period. Hence, a highly volatile period with instances of both under reaction and overreaction could give the impression of a stable market. This is what seems to have happened during these periods as market participants reacted to the information and news.

We also reviewed the literature on the integration of the Eurozone equity markets in the aftermath of the introduction of the Euro. We found most of the past empirical and literature pointed to an acceleration of the integration in the aftermath of the euro's introduction and during the bull market. However, this was slowed down in the aftermath of both crises; although, the literature does point to the sovereign debt crisis having a bigger impact than the financial crisis. Nevertheless, the real danger is in the rise of the populist and nationalist movements across Europe which depending on the views could result in the disintegration of the EU and thus the Eurozone. The case of Brexit and the resulting deal will no doubt be watched carefully with the potential of others to follow suit, there are already signs that the Italians want out.

A relevant factor to emerge from the Brexit and 2014 European Union parliamentary elections is that many people don't fully understand the workings and fundamental concept of the European Union. Hence, many on the opposing view are able to significantly highlight the weaknesses of the European Union. This points to a lack of communication by the European Union parliament. We therefore advise the European Union parliament to communicate more with the population in order to raise the awareness of the work and concept of the European Union. Another issue raised was the loss of a sense of national identity, therefore pushing a significant number to extreme nationalist. Although, I am a supporter of European integration; however, a policy of slower paced integration would be of benefit to most considering the rise in nationalist views within the European Union and Eurozone. A key issue raised by the recent crises is the miscommunication and disjointed actions by key politicians which resulted in the financial markets being highly volatile and over reactive. We recommend the setup of a committee to oversee the communication and actions, especially during any future crisis, which would help to stabilize the Eurozone financial markets and therefore lead to a more integrated financial market.

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